EXPERIMENT-5

VOLTAGE SERIES FEEDBACK AMPLIFIER

AIM: To design a Voltage Series Feedback Amplifier and to calculate the gain, feedback resistance, input resistance and to calculate the frequency response of Feedback Amplifer.

APPARATUS REQUIRED:

S. No	Components	Specifications	Quantity
1	Transistor(BC547) or (BC107)	β=150	2
2	Resistors	20KΩ 7KΩ 1KΩ 3KΩ 2.2KΩ	2 2 2 1 1
3	Capacitors	10μF 100μF 1μF	3 2 1
4	CRO	0-30MHz	1
5	Function Generator	Upto 3MHz	1
6	Bode Plotter		1

THEORY:

A Feedback amplifier is basically a type of gain adjusting amplifer. Based on the type of input and output(Whether it is current or voltage) there are 4 types of feedback amplifers. In Feedback amplifiers, some part of the output signal is fed back to the input. Based on this we have a positive and negative feedback amplifiers.It is determined if the signal is mixed at the input in-phase or out-of-phase. Negative feedback is mostly used since the distortion produced at the output is less compared to positive feedback.

The circuit which will feed the output signal back to input is called as feedback network or also known as 'β' network. The value of the β network determines the gain of the overall circuit.

DESIGN SPECIFICATIONS:

VCC = 12V, V_{CE} = 6V, I_C=2-3mA

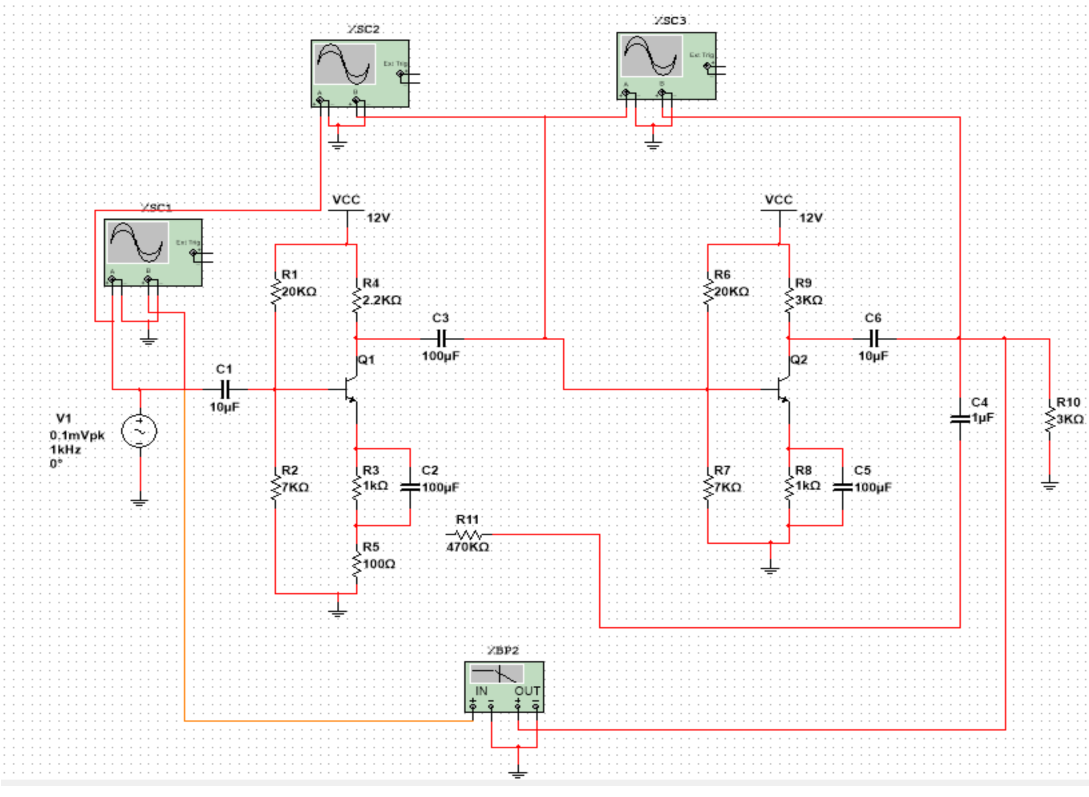
NPN transistor with ideal β=150.

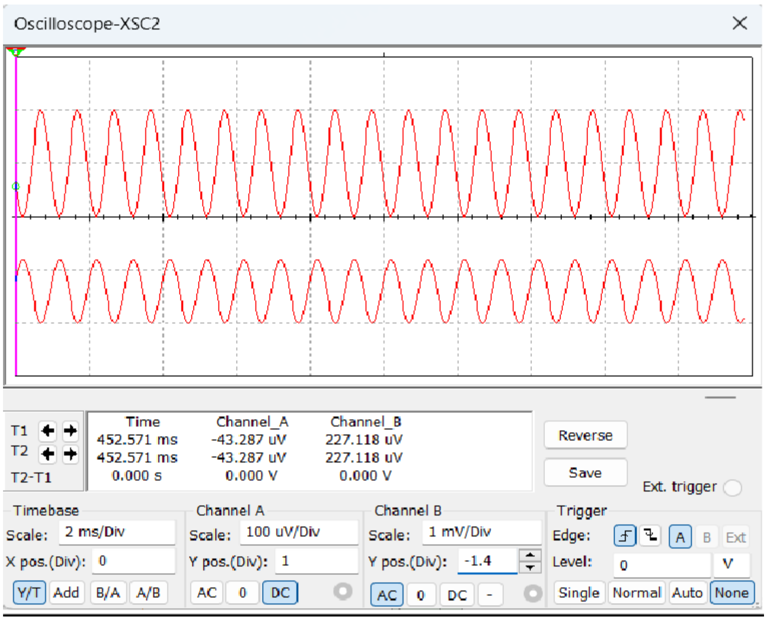
PROCEDURE (SOFTWARE):

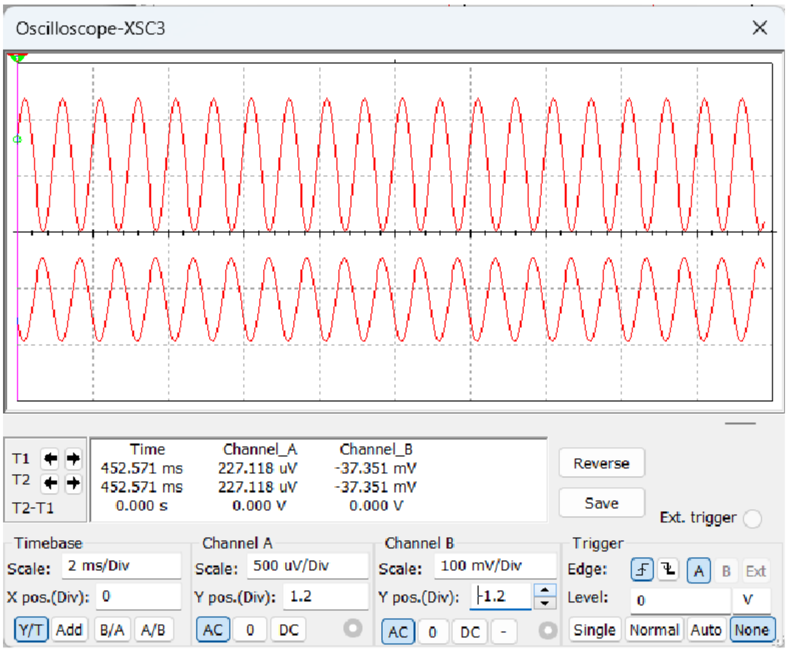
1. Open the Multisim software.
2. From the components toolbox bring the components required onto the workspace.
3. Connect the circuit components using wires.
4. Next adjust the values of the components as required.
5. From the Instrument toolbox bring the Oscilloscope and Connect one channel of the Oscilloscope to the input and another channel to the output for the first stage.
6. And to the another oscilloscope connect the output of first stage to one input and connect the output of the second stage to another channel.
7. Keep the Simulation in Interactive mode and run the design.
8. Observe the output and input waveform.

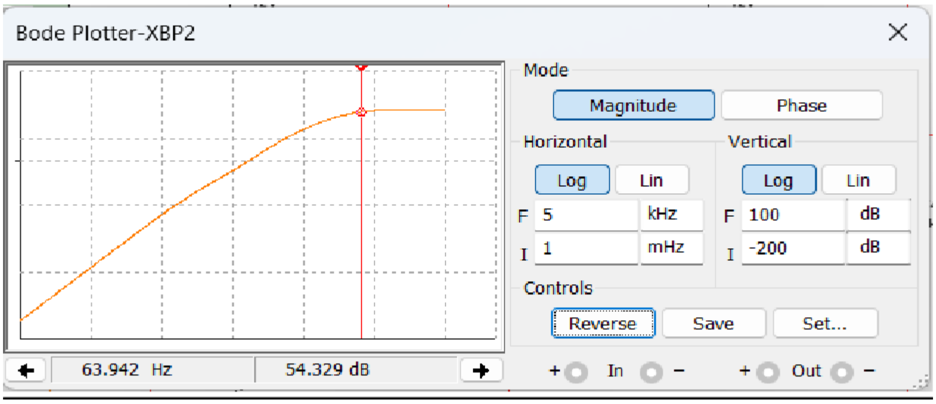
OBSERVATIONS:

CASE-1: Without feedback




Oscilloscope-XSC2
Time
Channel_A
Channel_B
T1
452.571 ms
-43.287 uV
227.118 uV
T2
452.571 ms
-43.287 uV
227.118 uV
T2-T1
0.000 s
0.000 V
0.000 V
Reverse
Save
Ext. trigger
Timebase
Scale: 2 ms/Div
X pos.(Div): 0
Y/T Add B/A A/B
Channel A
Scale: 100 uV/Div
Y pos.(Div): 1
AC 0 DC
Channel B
Scale: 1 mV/Div
Y pos.(Div): -1.4
AC 0 DC -
Trigger
Edge:
A B Ext
Level: 0 V
Single Normal Auto None


Oscilloscope-XSC3
Time
Channel_A
Channel_B
T1
452.571 ms
227.118 uV
-37.351 mV
T2
452.571 ms
227.118 uV
-37.351 mV
T2-T1
0.000 s
0.000 V
0.000 V
Reverse
Save
Ext. trigger
Timebase
Scale: 2 ms/Div
X pos.(Div): 0
Y/T Add B/A A/B
Channel A
Scale: 500 uV/Div
Y pos.(Div): 1.2
AC 0 DC
Channel B
Scale: 100 mV/Div
Y pos.(Div): -1.2
AC 0 DC -
Trigger
Edge:
A B Ext
Level: 0 V
Single Normal Auto None



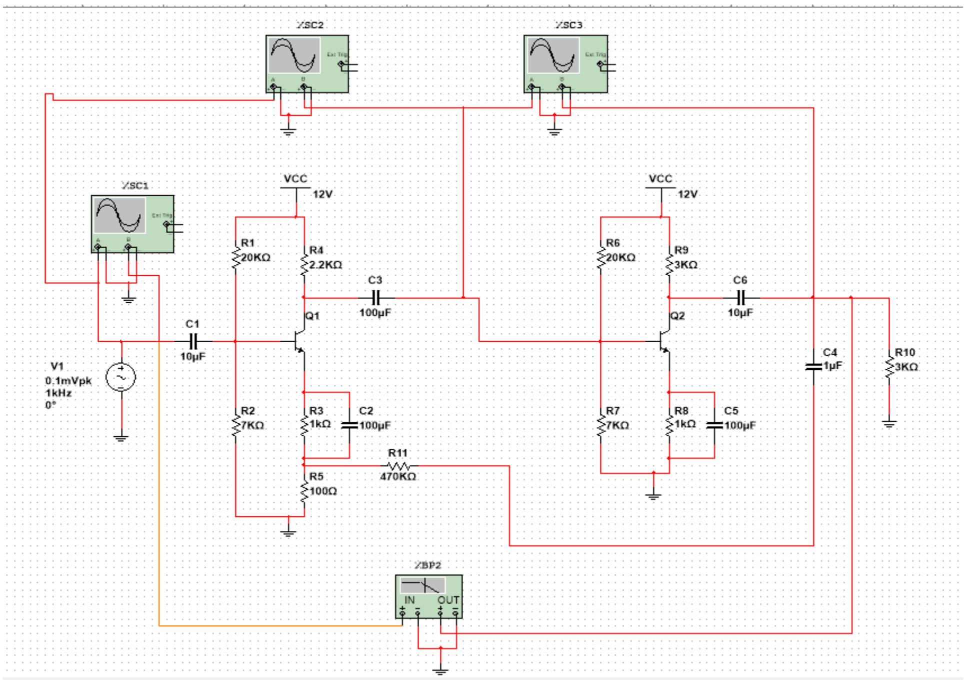
When there is no feedback, the amplifier is working as multistage amplifier. Cutoff frequency is at 54dB and the cutoff frequency of 64Hz.

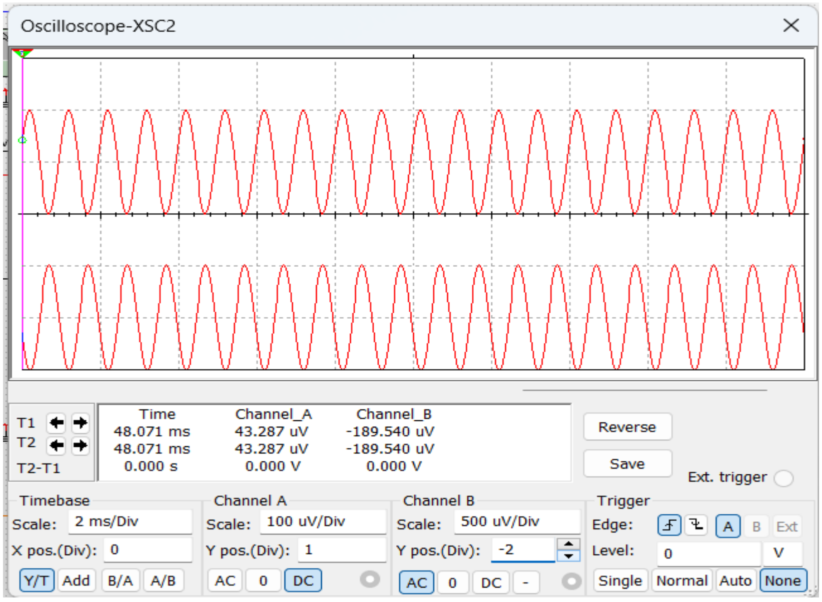
Gain of first stage of amplifier is (A1) = 6

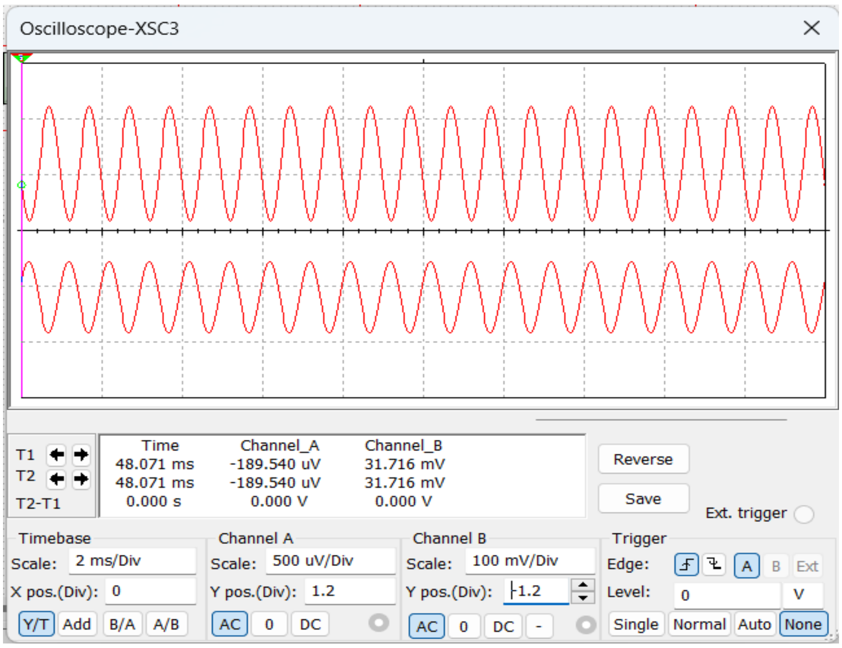
Gain of second stage of amplifier is (A2) = 125

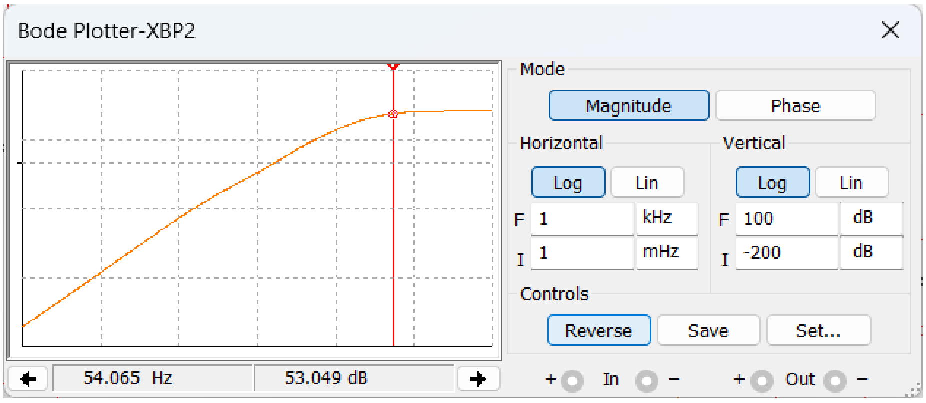
Overall gain of the circuit is (A) = A1*A2 = 750.

CASE-2: With Feedback resistance of 470KΩ




Oscilloscope-XSC2
T1
T2
T2-T1
Time
48.071 ms
48.071 ms
0.000 s
Channel_A
43.287 uV
43.287 uV
0.000 V
Channel_B
-189.540 uV
-189.540 uV
0.000 V
Reverse
Save
Ext. trigger
Timebase
Scale: 2 ms/Div
X pos.(Div): 0
Y/T Add B/A A/B
Channel A
Scale: 100 uV/Div
Y pos.(Div): 1
AC 0 DC
Channel B
Scale: 500 uV/Div
Y pos.(Div): -2
AC 0 DC -
Trigger
Edge: A B Ext
Level: 0 V
Single Normal Auto None


Oscilloscope-XSC3
T1
T2
T2-T1
Time
48.071 ms
48.071 ms
0.000 s
Channel_A
-189.540 uV
-189.540 uV
0.000 V
Channel_B
31.716 mV
31.716 mV
0.000 V
Reverse
Save
Ext. trigger
Timebase
Scale: 2 ms/Div
X pos.(Div): 0
Y/T Add B/A A/B
Channel A
Scale: 500 uV/Div
Y pos.(Div): 1.2
AC 0 DC
Channel B
Scale: 100 mV/Div
Y pos.(Div): 1.2
AC 0 DC -
Trigger
Edge: A B Ext
Level: 0 V
Single Normal Auto None


Bode Plotter-XBP2
Mode
Magnitude
Phase
Horizontal
Log Lin
F 1 kHz
I 1 mHz
Vertical
Log Lin
F 100 dB
I -200 dB
Controls
Reverse Save Set...
54.065 Hz
53.049 dB
+ In −
+ Out −

In the case of Feedback resistance at 470KΩ, the output almost seems to be equal to the output of the amplifier without feedback. This is due to high feedback resistance.

Due to high feedback resistance, maximum voltage gets dropped across the resistor and the signal does not get mixed at the input.

In this circuit, the mid frequency gain is obtained at 56dB. So, the cutoff frequency is at 53dB i.e., 54Hz.

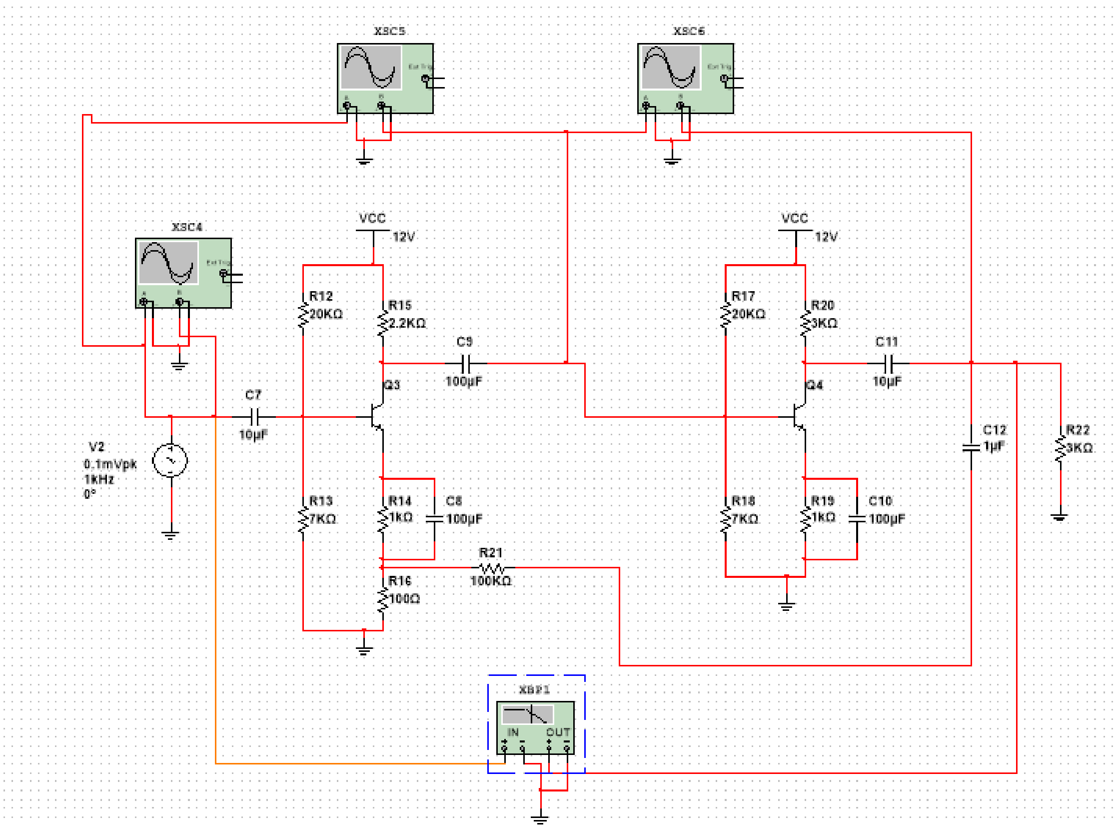
Gain of First stage (A1) = 5

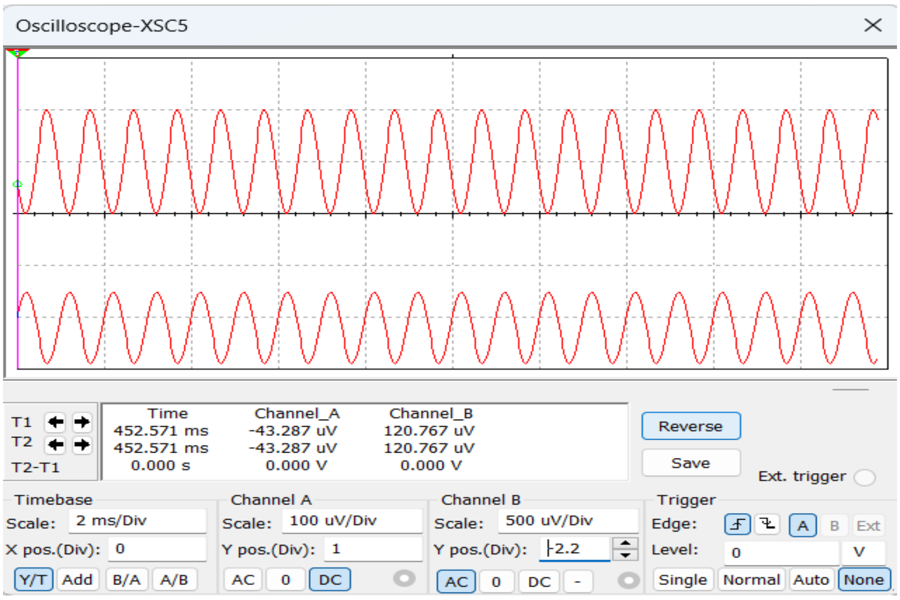
Gain of Second stage (A2) = 120

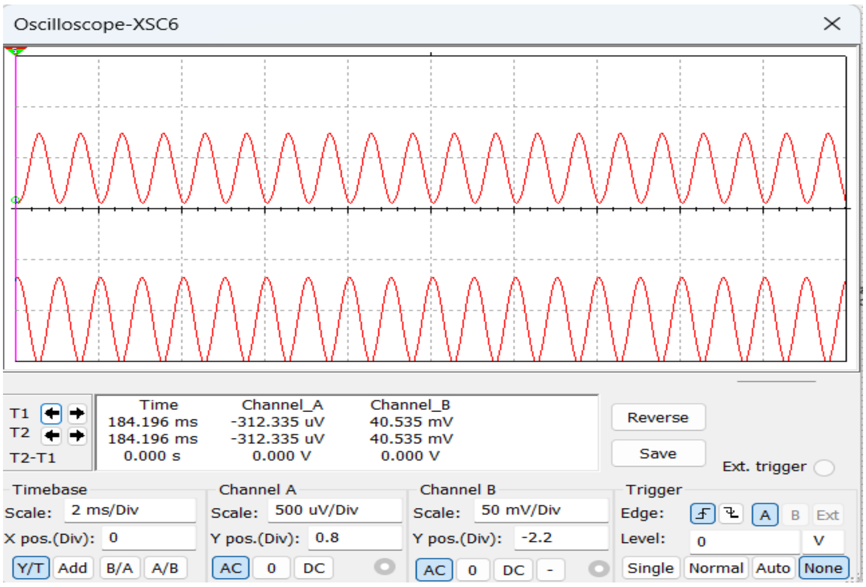
Gain of Overall circuit (A) = A1*A2 = 600

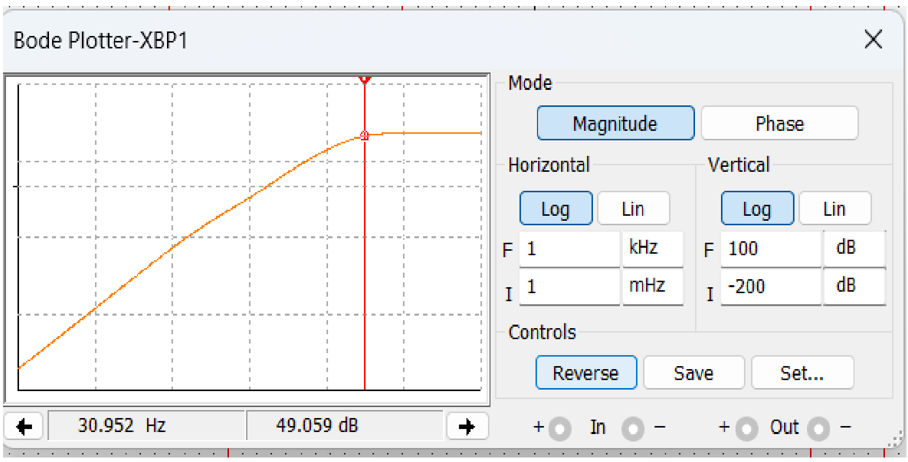
Let's reduce the feedback resistance in order to measure the gain.

<u>CASE-3:</u> With Feedback resistance at 100KΩ




Oscilloscope-XSC5
Time Channel_A Channel_B
T1 452.571 ms -43.287 uV 120.767 uV
T2 452.571 ms -43.287 uV 120.767 uV
T2-T1 0.000 s 0.000 V 0.000 V
Reverse
Save
Ext. trigger
Timebase
Scale: 2 ms/Div
X pos.(Div): 0
Y/T Add B/A A/B
Channel A
Scale: 100 uV/Div
Y pos.(Div): 1
AC 0 DC
Channel B
Scale: 500 uV/Div
Y pos.(Div): -2.2
AC 0 DC -
Trigger
Edge: A B Ext
Level: 0 V
Single Normal Auto None


Oscilloscope-XSC6
Time Channel_A Channel_B
T1 184.196 ms -312.335 uV 40.535 mV
T2 184.196 ms -312.335 uV 40.535 mV
T2-T1 0.000 s 0.000 V 0.000 V
Reverse
Save
Ext. trigger
Timebase
Scale: 2 ms/Div
X pos.(Div): 0
Y/T Add B/A A/B
Channel A
Scale: 500 uV/Div
Y pos.(Div): 0.8
AC 0 DC
Channel B
Scale: 50 mV/Div
Y pos.(Div): -2.2
AC 0 DC -
Trigger
Edge: A B Ext
Level: 0 V
Single Normal Auto None


Bode Plotter-XBP1
Mode
Magnitude Phase
Horizontal
Log Lin
F 1 kHz
I 1 mHz
Vertical
Log Lin
F 100 dB
I -200 dB
Controls
Reverse Save Set...
30.952 Hz
49.059 dB
+ In -
+ Out -

When the Feedback resistance is reduced to 100KΩ, the effect on the circuit is:

Gain of first stage(A1) = 3

Gain of Second stage(A2)=125

Gain of Overall circuit(A) = A1 * A2 = 375

When the Feedback resistance is reduced, then a maximum output signal reaches the first stage. So, the signal reaching the transistor(V_{in1}) reduces and thus the gain reduces.

$$V_{in1} = V_s - V_f$$

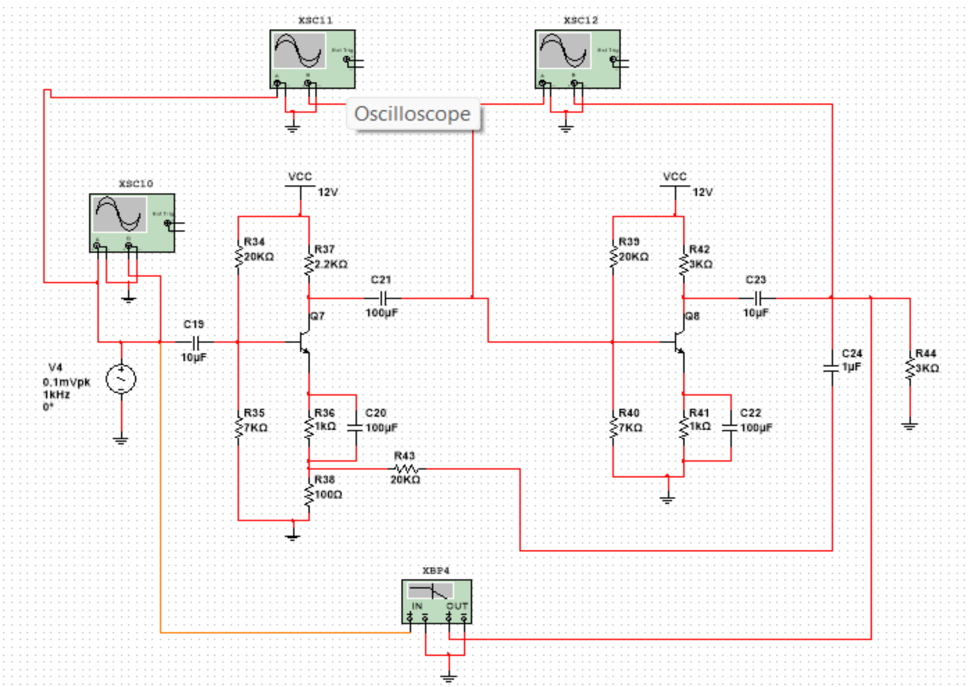
Where, V_{in1} = Input voltage to Transistor of first stage,

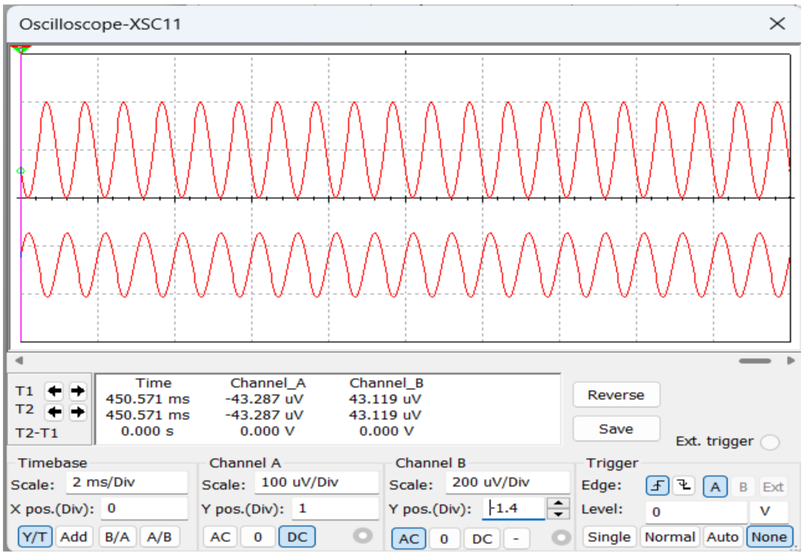
V_s = Source Voltage,

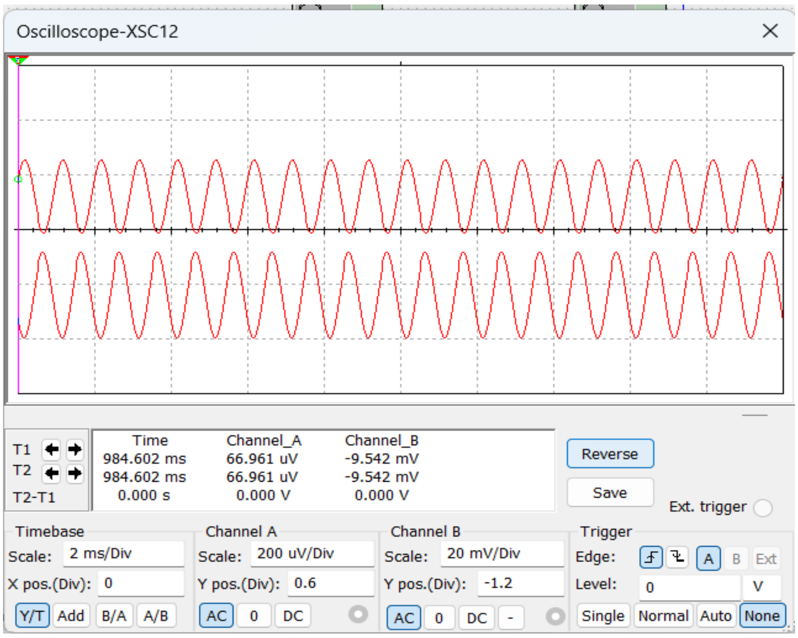
V_f = Feedback Voltage.

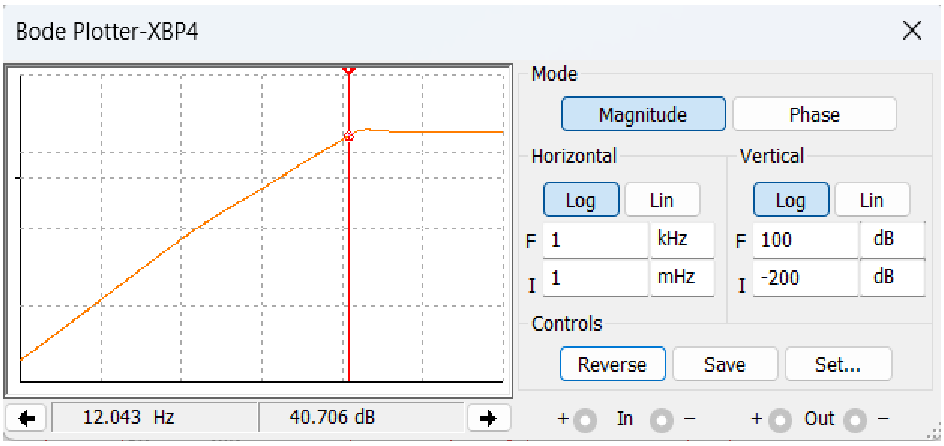
Mid frequency gain is obtained at 52dB. So, the Cutoff frequency is at 49dB i.e.,31Hz.

CASE-4: With Feedback resistance at 20KΩ




Oscilloscope-XSC11
T1
T2
T2-T1
Time
450.571 ms
450.571 ms
0.000 s
Channel_A
-43.287 uV
-43.287 uV
0.000 V
Channel_B
43.119 uV
43.119 uV
0.000 V
Reverse
Save
Ext. trigger
Timebase
Scale: 2 ms/Div
X pos.(Div): 0
Y/T Add B/A A/B
Channel A
Scale: 100 uV/Div
Y pos.(Div): 1
AC 0 DC
Channel B
Scale: 200 uV/Div
Y pos.(Div): -1.4
AC 0 DC -
Trigger
Edge: A B Ext
Level: 0 V
Single Normal Auto None


Oscilloscope-XSC12
T1
T2
T2-T1
Time
984.602 ms
984.602 ms
0.000 s
Channel_A
66.961 uV
66.961 uV
0.000 V
Channel_B
-9.542 mV
-9.542 mV
0.000 V
Reverse
Save
Ext. trigger
Timebase
Scale: 2 ms/Div
X pos.(Div): 0
Y/T Add B/A A/B
Channel A
Scale: 200 uV/Div
Y pos.(Div): 0.6
AC 0 DC
Channel B
Scale: 20 mV/Div
Y pos.(Div): -1.2
AC 0 DC -
Trigger
Edge: A B Ext
Level: 0 V
Single Normal Auto None


Bode Plotter-XBP4
Mode
Magnitude Phase
Horizontal
Log Lin
F 1 kHz
I 1 mHz
Vertical
Log Lin
F 100 dB
I -200 dB
Controls
Reverse Save Set...
12.043 Hz
40.706 dB
+ In −
+ Out −

When the Feedback resistance is reduced to 20KΩ, the gain of the circuit is:

Gain of First Stage(A1) = 1.4

Gain of Second Stage(A2) = 115

Gain of Overall circuit (A) = A1 * A2 = 161

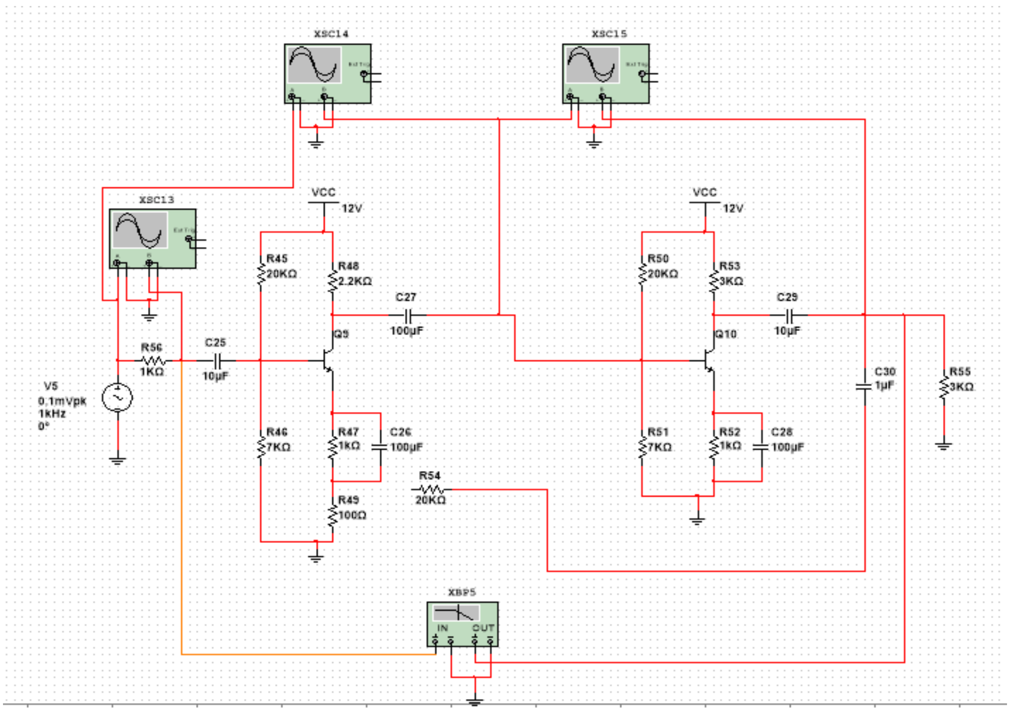
Gain is reduced compared to previous case indicating more signal voltage is getting mixed at the first stage.

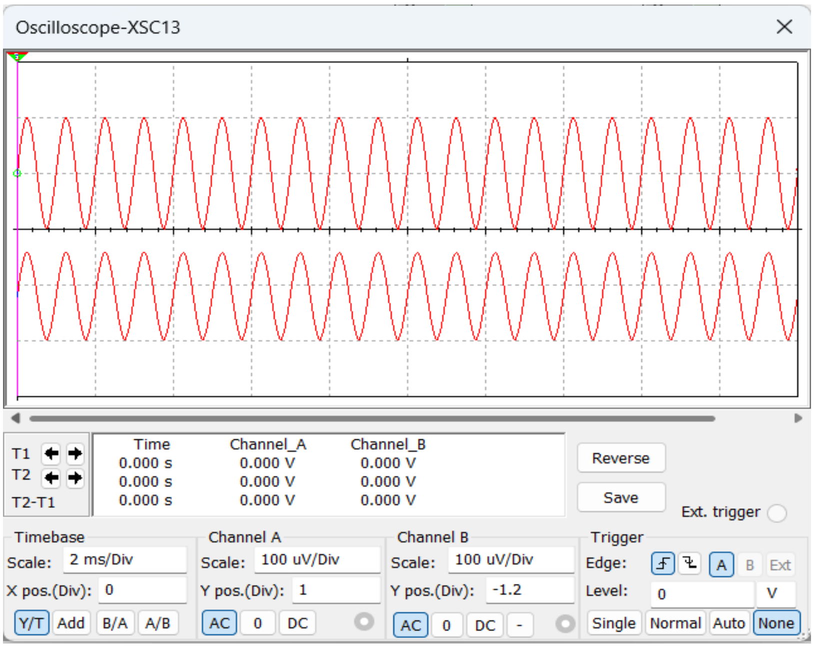
Mid frequency gain is obtained at 43dB. So, the Cutoff frequency is obtained at 40dB i.e., 12Hz.

Calculation of input resistance:

In case of multistage amplifers, the input resistance (or) source resistance should be equal to the resistance of the overall stage. If they match, maximum power can be transferred and loading effect can be reduced.

CASE-1: With Input resistance at 1KΩ and without feedback

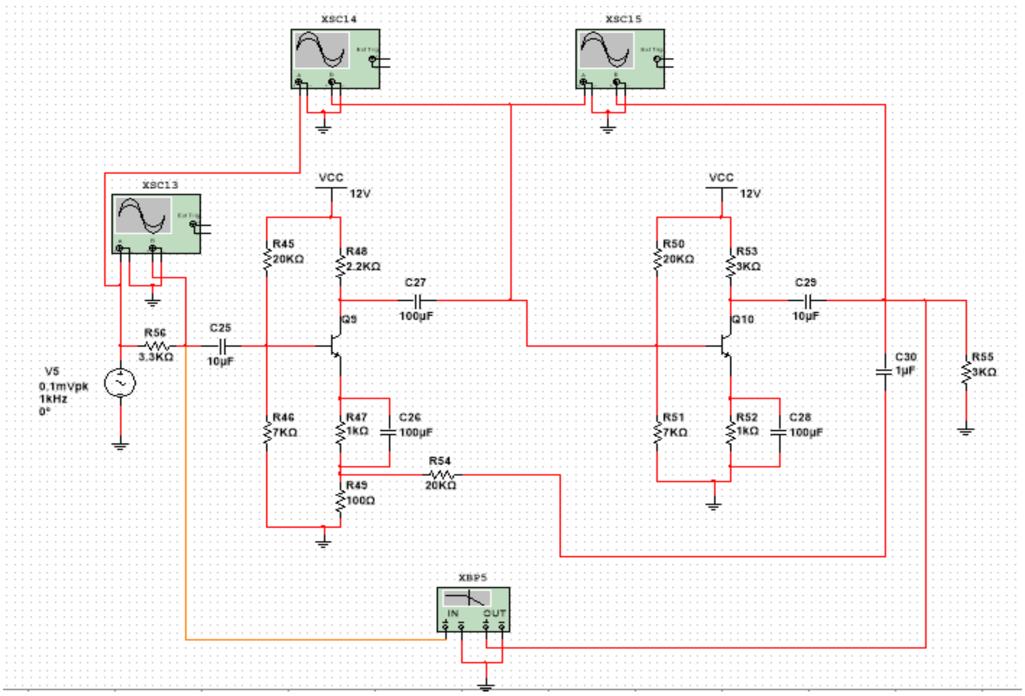


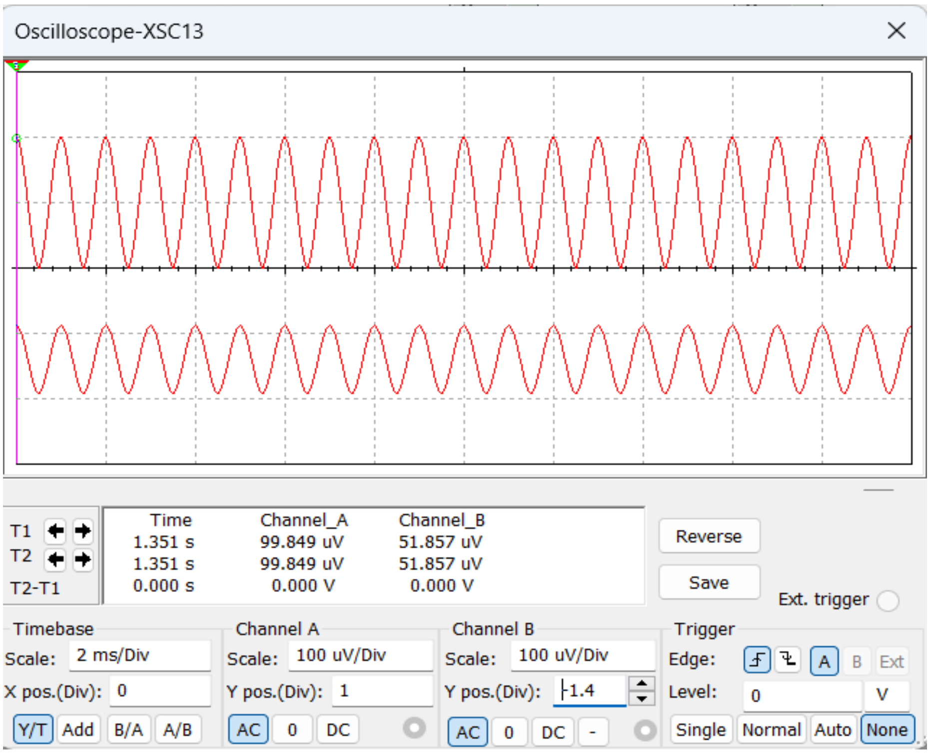


An input Voltage of 200µV is applied at the input. In order for maximum power transfer, the voltage drop at source resistance should be exactly half of the maximum supply.

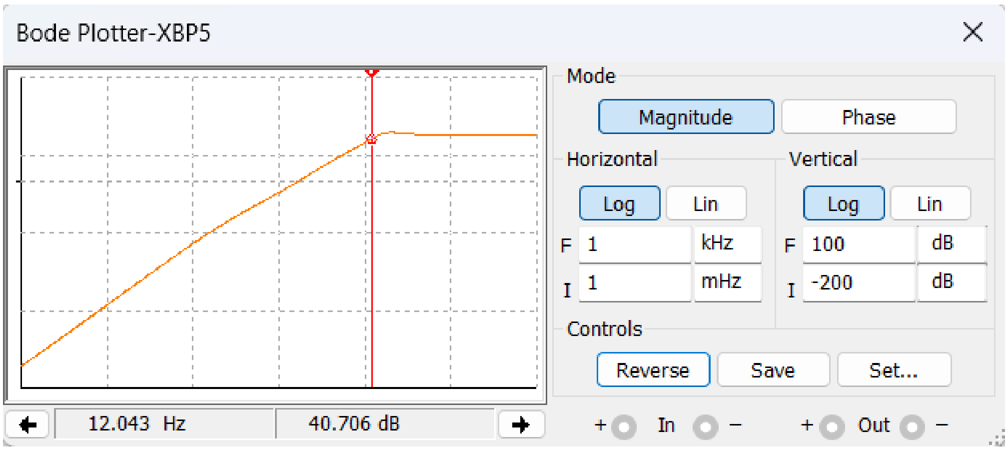
When the input (or) source resistance is at 1KΩ, voltage reaching the transistor is 150µV, which is 75% of the input. So, the input resistance cannot be equal to 1KΩ.

<u>CASE-2:</u> With input resistance at 3.3KΩ





When the input resistance is changed to 3.3KΩ, the voltage to the first transistor is exactly half of the supply. So, the input resistance for the circuit designed is 3.3KΩ.



For this Feedback amplifier with input resistance of 3.3KΩ, the mid frequency gain is obtained at 43dB. So, the Cutoff frequency is obtained at 40dB i.e., 12Hz.

OBSERVATIONS:

S.No.	Resistance(R_f)	Input(mV)	Output(V)	Voltage Gain(dB)
1	14k	60	7.8	130
2	45k	60	7.2	120
3	55k	60	6.6	110
4	56k	60	6.4	106
5	1M	60	4.7	78

RESULT:

An increase in feedback resistance R_f the overall voltage decreases.